What Is Ecosystem Management?

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Abstract: The evolving concept of ecosystem management is tie focus of much current debate To clarify discussion and provide a framework for implementation, I trace the historical development of ecosystem management, provide a working definition, and summarize dominant themes taken from an extensive literature review. The general goal of maintaining ecological integrity is discussed along with five specific goals: maintaining viable populations, ecosystem representation, maintaining ecological process (i e., natural disturbance regimes), protecting evolutionary potential of species and ecosystems, and accommodating human use in light of the above Short-term policy implications of ecosystem management for several groups of key actors (scientists, policymakers, managers, citizens) are discussed Long-term (>100 years) policy implications are also reviewed including reframing environmental values, fostering cooperation, and evaluating success Ecosystem management is not just about science nor is it simply an extension of traditional resource management; it offers a fundamental reframing of bow humans may work with nature.

Qué es manejo del ecosistema?

Resumen: *El concepto del manejo del ecosistema en desarrollo es el foco de gran parte del debate actual. A los efectos de clarificar esta discusión y proveer un marco para su implementación, reconstruyo el desarro110 histórico del manejo de ecosistemas, proveo una definición de trabajo y resumo los temas dominantes tomados de una extensa revi-sión bibliográfica. El objetiw general de mantener la integridad ecológica es discutido conjuntamente con cinco objetiws especificos: mantenimiento depoblaciones viables, representación de ecosistemas, mantenimiento de procesos ecológicos (i e., regímenes de perturbaciones naturales), protección del potencial ewlutiw de las especies y ecosistemas, y acomodc ::iento del uso bumano en función de lo anterior. Se discuten las implicaciones de las medidas de corto término en el manejo del ecosistema para distintos grupos de actores claves (cientificos, diseñadores de politicas, administradores, ciudadanos). También son consideradas las implicaciones a largo plazo de las medidas (> 100 años), incluyendo la reconsideración del marco de los valores ambientales. el fomento de la cooperación y la evaluación del éxito. El manejo del ccosistema no es ciencia sólamente ni la simple extensión del tradicional manejo de recursos; el manejo del ecosistema ofrece una reconsideración del marco de cdmo los bumanos podemos trabajar con la naturaleza.*

Introduction

Deep in a mixed conifer forest on the east side of the Washington Cascades, a U.S. Forest Service silviculturalist, responding to a college student's query, suggests that ecosystem management means snag retention and management of coarse woody debris on clearcut units.

In northern Florida on a U.S. Department of Defense reservation, a team of biologists and managers struggles with the design of a fire management plan in longleaf pine (*Pinus palustris*) forests that mimics natural disturbance regimes while minimizing the risk of burning adjacent private lands (USDOD Air Force 1993).

To avert what he calls "national train wrecks," Interior Secretary Bruce Babbitt announces that the Clinton Administration plans to shift federal policy away from a single species approach to one that looks "at entire ecosystems" (as quoted in Stevens 1993).

Commenting on a draft federal framework for the Greater Yellowstone Ecosystem that proposes increased interagency cooperation, a lawyer claims that "Congress

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does not intend that national forests should be managed like national parks" and that there exists no need to "create" ecosystem management (Budd 1991).

Other observers in the Greater Yellowstone region contend that an ecosystem approach could provide just the holistic management necessary for sustaining resources in a complex ecological/political landscape (Clark & Minta in press).

What is ecosystem management?

The above vignettes portray but a few of the various interpretations of ecosystem management that can be found in the conservation biology. resource management, and popular literature. Since the ecosystem approach is relatively new, and still unformed, this is not surprising. As any concept evolves, debates over definition, fundamental principles, and policy implications proceed apace. Yet the discussion surrounding ecosystem management is not merely academic, Nor is it limited to those scientists, resources professionals, and policymakers who work directly with federal management issues. The debate is raising profound questions for most people who are concerned with the continuing loss of biodiversity at all scales and across many administrative boundaries and ownerships. Along with defining the ecosystem management approach as a new policy framework there appears to be a parallel process of redefining the fundamental role of humans in nature.

This paper: (1) provides a brief outline of the historical development of the ecosystem management concept; (2) presents the key dominant themes of ecosystem management as derived from the literature; and (3) examines some of the more provocative short- and long-term policy implications of putting ecosystem management into practice. Discussion on ecosystem management has proceeded to a point where a status report is essential for further clarification, understanding, and implementation.

Historical Development of the Ecosystem Management Concept

Ecosystem management is a response to today's deepening biodiversity crisis. But a few visionary ecologists from the 1930s and 1940s had the foresight to advocate many specific elements of the contemporary ecosystem discussion. The contributions of Aldo Leopold (1949) in conservation science and philosophy are well known. Less well known is the 1932 work of the Ecological Society of America's Committee for the Study of Plant and Animal Communities that recognized that a comprehensive U.S. nature sanctuary system must protect ecosystems as well as particular species of concern, represent a wide range of ecosystem types, manage for ecological "fluctuations" (i.e., natural disturbances), and employ a core reserve/buffer zone approach (Shelford 1933). The Committee also realized that interagency cooperation would be required for success and that ecologists needed to "use every means to educate the public as to the value of sanctuaries." The idea that nature could be "improved" upon by management was also challenged.

In their classic study, *Fauna of the National Parks Of the US.* biologists George Wright and Ben Thompson (1935) observed that parks were not fully functional ecosystems "by virtue of boundary and size limitations." Wright lobbied for increasing the size of parks by redrawing their boundaries to reflect biotic requirements of large mammals. but his untimely death cut his efforts short. In 1950, the Ecological Society's Committee for the Study of Plant and Animal Communities proposed a strategy to implement Shelford's nature sanctuary inventory (Kendeigh et al. 1950–1951). These early attempts to ground resource management better in ecology and landscape-level concerns were not successful.

In 1970, policy analyst Lynton Caldwell (1970) published an article that advocated using ecosystems as the basis for public land policy. Caldwell understood that to do so "would require that the conventional [political] matrix be unraveled and rewoven in a new pattern." It is significant that the blossoming of the U.S. environmental movement in the 1970s was not strong enough politically to influence such a reconfiguration.

Biologists Frank and John Craighead are generally credited with focusing current attention on ecosystem management. Twelve years of grizzly bear (*Ursus arctos*) population research showed the Craigheads that the bears' needs could not be met solely within the borders of Yellowstone National Park (Craighead 1979). They suggested that the Yellowstone population required at least 5,000,000 acres of protected habitat. Craighead's pioneering work set a fundamental criterion for defining greater ecosystems: the area must provide the primary habitat necessary to sustain the largest carnivore in a region. William Newmark's (1985) work comparing the legal and biotic boundaries of various parks and reserves in western North America reinforced Craighead's conclusions.

By the late 1980s an ecosystem approach to land management was being supported by many scientists, managers, and others. Proposals focused on specific regions such as Yellowstone (Clark & Zaunbrecher 1987; Clark & Harvey 1988) and the North Cascades of Washington state (Friedman 1988; Grumbine 1988*b*), the single species approach to conservation (Hutto et al. 1987), the relationship between population viability and interagency behavior (Salwasser et al. 1987) and the legal implications of ecosystem management (Keiter 1989, 1990).

The first book-length treatment on ecosystem management appeared in 1988. Jim Agee and Darryll Johnson (1988) presented a theoretical framework that included both general goals and processes for achieving goals. These authors embedded ecosystem management

within a dynamic pattern-and-process view of nature. They suggested that ecologically defined boundaries, clearly stated management goals, interagency cooperation, monitoring of management results, and leadership at the national policy level were essential elements. Agee and Johnson also brought people directly into the equation; managers could no longer discount the effects of humans in ecosystems. In the opinion of these authors, managers and biologists must keep in mind the complex social context of their work.

Even as Agee and Johnson (1988) admitted that defining ecosystem boundaries in a dynamic world was at best an inexact art, they also wrestled with how to define management goals in a sociopolitical realm that is also never static. They made a key assumption that since what is natural "cannot be scientifically resolved" management goals must rest on achieving "socially desirable conditions."

Since the publication of Agee and Johnson's (1988) work, there has been an outpouring of papers examining the ecosystem management concept. Keiter (1989) focused on important legal aspects of ecosystem management in a lengthy monograph. The first interagency attempt to apply ecosystem management to federal lands was issued in draft form in 1990 (Greater Yellowstone Coordinating Committee 1990) only to become the subject of intense political debate which soon led to its demise (see Lichtman & Clark in press). In 1991, California became the first state to address biological impoverishment through a policy based largely on ecosystem concepts (California, State of 1991). in what was touted as major policy reform, the U.S. Forest Service in 1992 altered its resource-based management focus to fit the agency's particular vision of ecosystem management (USDA Forest Service 1992). Among recent works Grumbine (1992), Clark (1993). and Clark and Minta (in press) offer the broadest treatments of the biological, sociopolitical, values, and policy process aspects of the ecosystem management concept.

Ecosystem management has not evolved in a vacuum. There are several major reasons why the debate is gaining momentum. First, the biodiversity crisis continues to accelerate (for an overview, see Noss & Cooperrider 1994). Second, no policy initiatives have as yet been shown to slow down environmental deterioration (Soulé 1991). Third, calls for ecosystem management have increased in conjunction with the theoretical and empirical development of conservation biology (Grumbine in press c). Fourth, the safety net of U.S. environmental laws is being stretched thin as society reaches and exceeds environmental limits through industrial expansion, population growth, and resource consumption (Doremus 1991). Fifth, environmental groups have increasingly used administrative appeals and litigation to challenge successfully current resource management policies and practices (Grumbine 1992). Sixth, federal management, as exemplified by national forest planning has (so far) failed legal tests, ignored conservation biology concerns, and left the public's expectations for meaningful participation in decision making unfulfilled (Grumbine in press 6). Seventh, societal views of appropriate relationships between people and nature are in a state of flux (Dunlap & Mertig 1992). It appears that many citizens are asking for less development of ecosystems and more protection and restoration. All three trends are interactive and are evolving at different rates and scales. Given these seven points, it is not at all clear what the new cultural and political landscape of management will look like over the long term or even in the next five years.

Dominant Themes of Ecosystem Management

Ecosystem management has not been uniformly defined or consistently applied by federal or state management agencies. Yet consensus is developing, at least within the academic literature. Using standard keyword search techniques focused on "ecosystem management," "ecosystem- health," "biodiversity management," "adaptive management," etc., I surveyed papers published on ecosystem management in peer reviewed journals (*Conservation Biology, Environmental Management, Ecological Applications, Society and Natural Resources, etc.*) up through June 1993 to determine where agreement exists on the subject. Articles came from a broad spectrum of disciplines including conservation biology, resource management, and public policy. I also reviewed books with substantive accounts of ecosystem management, lay environmental publications, and several federal and state-level documents that discuss ecosystem-level policymaking.

Ten dominant themes of ecosystem management emerged from my review (see Table 1). (Note that Table 1 lists only the sources that offer the most detailed accounts of ecosystem management.) Dominant themes were those attributes that authors identified explicitly as critical to the definition, implementation, or overall comprehension of ecosystem management. The ten dominant themes emerged repeatedly throughout the literature. I believe the following themes faithfully represent areas of agreement. (No literature citations are given below for specific themes since most of the papers refers to each of them-see Table 1 for exceptions.)

The ten dominant themes of ecosystem management are:

1. **Hierarchical Context A** focus on any one level of the biodiversity hierarchy (genes, species, populations, ecosystems, landscapes) is not sufficient. When working on a problem at any one level or scale, managers must seek the connections between all levels. This is often described as a "systems" perspective.

2. **Ecological Boundaries.** Management requires working across administrative/political boundaries (i.e., national forests, national parks) and defining ecological

Table 1. Dominant themes of ecosystem management

Source	Hierarchical Context	Ecological Boundaries	Ecological Integrity: Viable Populations	Ecological Integrity: Ecosystem Patterns and Processes	Ecological Integrity: Species Reintroduction	Data Collection	Monitoring	Interagency Cooperation	Organizational Change	Adaptive Management	Humans as Part of Nature	Values
Shelford 1933		X		X	X	X		X				
Wright & Thompson 1935		X										
Caldwell 1970				X								
Craighead 1979		X	X						X			
Clark & Zaunbrecher 1987	X	X	X	X	X	X	X	X	X	X	X	
Agee & Johnson 1988	X	X	X	X		X	X	X		X	X	
Grumbine 1988*b*		X	X		X	X	X	X	X	X	X	X
Clark & Harvey 1988	X	X	X	X	X	X	X	X	X	X	X	X
Keiter 1989		X	X	X	X	X	X				X	X
Grumbine 1990*a*		X	X	X	X	X	X	X	X		X	X
Grumbine 1990*b*	X	X	X	X	X	X	X	X	X	X		X
Greater Yellowstone Coord. Comm. 1990			X	X	X	X	X	X	X	X		X
Keiter & Boyce 1991	X	X	X	X		X	X					
California, State of 1991	X		X	X	X		X	X		X	X	
Clark et al. 1991		X	X	X	X	X	X	X	X		X	X
Grumbine 1992		X	X	X	X	X	X	X	X	X		X
Goldstein 1992	X	X	X	X	X	X	X	X	X	X	X	X
USDA Forest Service 1992	X		X	X	X	X	X	X		X	X	
Norton 1992	X		X	X	X	X	X	X	X	X	X	X
Kessler et al. 1992	X			X			X	X	X	X	X	X
Noss 1992	X	X	X	X	X	X	X	X		X	X	
Cawley & Freemuth 1993	X	X				X		X	X		X	X
MacKenzie 1993	X		X	X	X	X	X	X	X		X	X
Quigley & McDonald 1993	X		X	X	X	X	X	X	X		X	X
Frost 1993	X	X	X	X	X	X	X	X		X		X
USDOD 1993	X		X	X	X	X	X	X		X	X	X
USDA Forest Service 1993	X	X	X	X	X	X	X	X		X	X	X
Clark 1993					X	X	X	X	X		X	X
Clark & Miinta in press	X	X	X	X	X	X	X	X	X	X	X	X
Cortner & Moote in press	X		X						X	X	X	X
Grumbine in press	X	X	X	X	X	X	X	X	X		X	X
Noss & Cooperrider 1994	X	X	X	X	X	X	X	X		X	X	X
Primm & Clark in press		X	X	X		X	X	X	X		X	X

boundaries at appropriate scales. An example would be Craighead's (1979) initial call for grizzly bear management based on the distribution and habitat requirements of the Greater Yellowstone population, not just Yellowstone National Park.

3. Ecological Integrity. Norton (1992) defines managing for ecological integrity as protecting total native diversity (species, populations, ecosystems) and the ecological patterns and processes that maintain that diversity. Most authors discuss this as conservation of viable populations of native species, maintaining natural disturbance regimes, reintroduction of native, extir-

patcd spccics, representation of ecosystems across natural ranges of variation, etc.

4. **Data Collection.** Ecosystem management requires more research and data collection (i.e., habitat inventory/classification, disturbance regime dynamics, baseline species and population assessment) as well as better management and use of existing data.

5. **Monitoring.** Managers must track the results of their actions so that success or failure may be evaluated quantitatively. Monitoring creates an ongoing feedback loop of useful information.

6. **Adaptive Management.** Adaptive management assumes that scientific knowledge is provisional and focuses on management as a learning process or continuous experiment where incorporating the results of previous actions allows managers to remain flexible and adapt to uncertainty (see Holling 1978; Walters 1986).

7. **Interagency Cooperation.** Using ecological boundaries requires cooperation between federal, state, and local management agencies as well as private parties. Managers must learn to work together and integrate conflicting legal mandates and management goals.

8. **Organizational Change.** Implementing ecosystem management requires changes in the structure of land management agencies and the way they operate. These may range from the simple (forming an interagency committee) to the complex (changing professional norms, altering power relationships).

9. **Humans Embedded in Nature.** People cannot be separated from nature. Humans are fundamental influences on ecological patterns and processes and are in turn affected by them.

10. **Values.** Regardless of the role of scientific knowledge, human values play a dominant role in' ecosystem management goals.

These ten dominant themes form the basis of a working definition: ***Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term***

Though there is a developing consensus on this definition, relatively few authors touch upon all ten themes or consider each of them to be equally important. The most comprehensive treatments are Grumbine (1992), Clark and Minta (in press), and Noss and Cooperrider (1994). It is interesting to note that the dominant themes least referred to arc organizational change, adaptive management, and values. The majority of authors who are biologists emphasize the scientific aspects of ecosystem management. They also tend to underestimate (1) the policy implications of changing power relationships and (2) the complexities of blending diverse human values into management. And, with the exception of Clark et al. (1991), Clark (1993), Primm and Clark (in press), and Keiter (1989, 1990). the few policy analysts who have written on ecosystem management (Cawlcy & Frccmuth 1993; Cortner & Moote in press) do not appear to have read widely in the conservation biology literature.

Ecosystem Management Goals

Most of the authors cited in this review agree that setting clear goals is crucial to the success of ecosystem management. Within the overall goal of sustaining ecological integrity, five specific goals were frequently endorsed:

1. Maintain viable populations of all native species in situ.
2. Represent, within protected areas, all native ecosystem types across their natural range of variation.
3. Maintain evolutionary and ecological processes (i.e., disturbance regimes, hydrological processes, nutrient cycles, etc.)
4. Manage over periods of time long enough to maintain the evolutionary potential of species and ecosystems.
5. Accommodate human use and occupancy within these constraints.

The first four of these goals are value statements derived from current scientific knowledge that aim to reduce (and eventually eliminate) the biodiversity crisis. The fifth goal acknowledges the vital (if problematic) role that people have to play in all aspects of the ecosystem management debate.

These fundamental goals provide a striking contrast to the goals of traditional resource management (see Knight & Bates in press). Though different agencies operate under a variety of federal and state mandates, current resource management in the U.S. is based on maximizing production of goods and services, whether these involve number of board feet (commodities) or wilderness recreational visitor days (amenities). Managers and lawmakers have always been careful to speak of "balance" and "sustained yield" but this language is obfuscatory—balance has never been defined in any U.S. environmental law and sustained yield has often been confused with sustainability (see Korten 199 l-1992; Brown et al. 1987; Grumbine in press 6).

If ecosystem management is to take hold and flourish, the relationship between the new goal of protecting ecological integrity and the old standard of providing goods and services for humans must be reconciled. Much of the oft-complained "fuzziness" or lack of precision surrounding ecosystem management derives from alternative views on this point. Kessler et al. (1992). for example, suggest that ecosystem management represents a further evolution of multiple use, sustained yield policy where managers "must not ***diminish***

the importance of products and services, but instead treat them within a broader ecological and social context" (emphasis added). These authors envision ecosystem-level management as an expansion of focus from particular resource outputs to the ecosystem as "life support system (for humans)." Kessler et al. fail to see that expanding the scale of concern by itself does not address the fact that there are certain ecological limits in any system which constrain human use. Ecological integrity as expressed by the five specific goals explicitly considers all resource use as a managerial artifact that may flow sustainably from natural systems only if basic ecosystem patterns and processes are maintained.



Echoing Kessler et al. (1992), the most detailed Forest Service working definition of ecosystem management (USDA Forest Service 19936) exemplifies lack of clarity over the key policy problem of defining ecosystem management goals. The report defines the philosophy of ecosystem management as sustaining "the patterns and processes of ecosystems for the benefit of future generations, while providing goods and services for each generation'* (USDA Forest Service 19936). The study characterizes the main limiting factors to ecosystem management as defining societal expectations, integrating these expectations with the sustainable capabilities of ecosystems, and filling information gaps in baseline data describing historical ecosystem variability and disturbance regimes. The Forest Service prescribes adaptive management as a process to blend ecosystem sustainability and human concerns. Specific solutions offered, however, are problematic. If societal goals conflict with ecosystem sustainability, cost/benefit analyses are offered as the standard for solutions. Adaptive management is described as an ongoing experiment yet "landscapes can be restored," managers are said to already be capable of mimicking natural disturbance regimes successfully, and there is speculation that future experiments may reveal new sustainable ecosystem states that may differ from evolutionary and historical states. In short, the Forest Service defines the goals of ecosystem management narrowly within the old resource management paradigm ("for the benefit of future generations") and seeks to operationalize this goal within a positivistic scientific framework. These characterizations of ecosystem management are also found in the other government policy documents in this review (Greater Yellowstone Coordinating Committee 1990; California, State of 1990; California, State of 199 1; USDA Forest Service 1992; USDOD Air Force 1993).

As several analysts point out, however, it takes more than scientific knowledge to reframe successfully complex policy problems. Knowledge of organizational structure and behavior as well as the policy process itself are equally important (Clark 1993; Primm & Clark in press). Yet none of the five government treatments of the ecosystem management concept reviewed here mention substantive organizational change, nor do they discuss the policy process as it is defined by policy scientists (see Brewer & deLeon 1983; Clark 1992; Primm & Clark in press). This emphasis on science is an artifact of the training and professional norms of the major group writing about ecosystem management—scientists. 3ut defining ecosystem management goals is also a political process; those authors advocating a new vision of ecological integrity (Clark & Zaunbrechet 1987; Keiter 1989; Grumbine 1992; Goldstein 1992; Noss 1992; Frost 1993; Noss & Cooperrider 1994) are more often employed independently or in academia. Authors affiliated with government agencies (Agee & Johnson 1988; Kessler et al. 1992; Quigley & McDonald 1993) tend to support the Forest Service version of ecosystem management. As policy analyst Tim Clark (personal communication) has pointed out, "The ecosystem management debate is really a complex, competitive, conflictual social process about whose values will dominate, it is not about science."

Management goals are statements of values—certain outcomes are selected over others. Choosing the management goal of maintaining ecological integrity along with the five specific goals may be debated, but in the academic and popular literature there is general agreement that maintaining ecosystem integrity should take precedence over any other management goal (Shelford 1933; Caldwell 1970; Newmark 1985; Clark & Harvey 1988; Keiter 1989; Grumbine 1992; Noss 1992; Norton 1992; Rasker 1993; Goldstein 1992; Myers 1993; Clark & Minta in press). This may be due partially to the fact that, given the rate and scale of environmental deterioration along with our profound scientific ignorance of ecological patterns and processes, we are in no position to make judgments about what ecosystem elements to favor in our management efforts. An increasing number of people also believe that humans do not have any privileged ethical standing from which to arbitrate these types of questions (Dunlap & Mertig 1992; Fox 1990).

Short-Term Policy Implications

With the knowledge of a working definition, dominant themes, and fundamental goals of ecosystem management, specific policy implications come into focus. In the short term (5 to 10 years), implementing ecosystem management will likely entail many of the following policy goals. For clarity, I have divided these goals up among four groups: scientists policymakers, managers, and citizens, Note, however, that the boundaries between these groups are quite permeable.

A. Scientists

Biologists must work to better use existing data on biodiversity at all scales. Adopting standard definitions,

measures and procedures would be a first step. A variety of examples would include clarification of keystone species (Mills et al. 1993) and biological corridors (Simberloff et al. 1992), the convening of an Ecological Society of America panel on ecosystem management. the gap analysis project of the U.S. Fish and Wildlife Service (Scott et al. 1993), and the recent efforts by the U.S. Forest Service to determine the natural range and variation of ecosystem conditions (USDA Forest Service 1993*a*). New applied research must also be initiated. Two areas of research are critical-the design of a continental-scale biodiversity protection network built around a system of core reserves, buffer zones, and habitat corridors (see Grumbine 1992; Noss 1992; Noss & Cooperrider 1994), and sustainable methods for using some of the products of ecosystems derived from the buffers and matrices of nonreserved lands. New forestry (Swanson & Franklin 1992) and ecoforestry (Hammond 1992; Drengson & Stevens 1993) both hold promise. Research results need to be accessible-construction of local, regional, and national data networks and clearinghouses would facilitate this.

B. Policymakers

Congress and the Administration have four roles to play in exercising ecosystem management leadership. First, lawmakers need to revisit and strengthen key environmental laws. The Endangered Species Act, the National Forest Management Act, and the National Environmental Policy Act, to name three, must be revised to make biodiversity protection paramount. Second, new laws and policies should be considered that would codify biodiversity protection nationally, commission a national biological survey, and support species reintroductions (i.e., the northern grey wolf [*Canis lupus*] in Yellowstone National Park). Other policies could end below-cost timber sales (the steps already taken by the Clinton Administration [Schneider 1993] need to be expanded to include all timber producing federal lands), tie public lands grazing levels to the ecological health of rangelands, suspend development of unroaded wildlands pending study of their potential contribution to a biodiversity protection network, and create an interdisciplinary team of experts to explore a variety of ways to reorganize federal and state resource management agencies to better meet these goals. Third, regional economic studies should be commissioned to examine the question "What is sustainable?" Rasker (1993) and Power (1991) provide useful models for the Greater Yellowstone Ecosystem. Finally, policymakers must successfully confront issues of population growth and resource consumption in the U.S. Ecosystem management has little chance of success without being embedded in the broader context of reducing growth in industrial societies.

C. Managers

Agency managers need to begin instituting ecosystem management on at least two levels. The first is relatively simple-gain an understanding of conservation science and hire more staff conservation biologists. The second level, fostering cooperation and opening up the decision making process, is more difficult because it leads directly toward changes in power relationships among players in the implementation game. The strength of the Forest Service's current ecosystem management policy is that it explicitly calls for greater partnerships between scientists. managers. and citizens (USDA Forest Service 1992). The weakness of the policy is that the agency (as well as many of the authors I reviewed. i.e., Salwasser et al. 1987; Agee & Johnson 1988; Greater Yellowstone Coordinating Committee 1990; California, State of 1991; Kessler et al. 1992; Swanson & Franklin 1992; Stevens 1993; Quigley & McDonald 1993; MacKenzie 1993; Cawley & Freemuth 1993; USDOD 1993) seems to be unaware of the radical implications of creating these partnerships. Management through dialog and cooperation at local and regional levels will be quite different from management imposed bureaucratically. For example, how might managers establish a common base of information among people with widely varying levels of knowledge and disparate values? Are "experts" capable of playing less powerful roles in decision making? If everyone has an equal voice in decision making, who takes responsibility for implementation? How can consensus be facilitated in an increasingly multicultural society (see Dustin et al. in press)? How can time-consuming decision processes be reconciled with judgments that demand speedy resolution? As a first step, if the agencies are serious about cooperating, they need to gain knowledge of the policy process as outlined by Clark (1993) just as much as they need a crash course in conservation science.

D. Citizens

Over the short term, citizen support for ecosystem management must manifest itself in two areas: ecological literacy and environmental advocacy. Both of these rest on the belief that public mores in the U.S. have for too long emphasized the rights of individuals to use resources while discounting ecologically responsible behavior. Orr (1992) defines ecological literacy as the ability to ask the question "What then?" and to understand the answer. I assume here that if people were better informed about the causes and consequences of the biodiversity crisis they would be more supportive of ecosystem management. This assumption needs to be tested through increased support for a variety of forms of environmental education that directly involve people with nature (see Grumbine 1988*a*; Fleischner & Weisberg 1992; Orr 1992).

A complementary approach to testing public support for ecosystem management would bc to grant citizens a greater role in environmental decision making. The complexities of this issue go beyond the scope of this paper but several observations can be made. The Forest Service (as the paradigmatic example) has been critiqued for employing a rational-comprehensive approach to public participation (U.S. Congress OTA 1992; Grumbine 1992). Publishing information filtered bureaucratically and offering alternatives already "preferred," the agencies discmpower citizens. Common problems are lack of trust, poor communications, power differentials between stakeholders, turf protection, and lack of public involvement after decisions are made. The Forest Service has responded recently by stating that citizens are to be involved in the "full process of making decisions about common resources" (USDA Forest Service 1992). Yet the policy does not specify what "full process" means (Grumbine in press *b*). Most of the authors cited in this review agree that "full process" should mean more local decision making. This implies less direction from regional and national authorities. Establishing a common information base, including all affected parties, stating expectations and limits explicitly, using local leaders to help establish trust and credibility. keeping communication channels open, and increasing investment in preparation and time in relation to complexity of decisions are antidotes to the problems listed above (see Landre & Knuth 1993; MacKenzie 1993; Hough 1988). (No paper that 1 reviewed, however, dealt substantively with issues of local control versus national interest, i.e., the dangers of discounting biodiversity due to narrow provincial concerns.) Over the short term, both MacKenzie (1993) and Primm and Clark (in press) suggest that, though ecosystem management has radical implications, it is often best to adopt an incremental approach so that goals and expectations do not reach beyond the capacity for change of institutional actors.

Long-Term Policy Implications

The shift toward ecosystem management is often described as movement away from a single species approach to a whole systems, multispecies framework This is only partially true. As should now be clear, ecosystem management is not just about science, nor is it simply an extension of traditional resource management. Implementation of ecosystem management requires a "seismic shift" in the mindset of humans (see Myers 1993). This review has already raised enough questions to make speculation about the future somewhat superfluous. But I believe such conjecture is warranted because, if the goal of ecological integrity becomes the norm, management a century hence holds great promise for not only sustaining ecosystems but also for integrating culture with nature. Changes of the kind described below have more to do with ethical responsibility than with ecosystem science. Here are but a few of the more provocative long-term (> 100 years) implications.

Reframing Environmental Values

Ecosystem management is an early stage in a fundamental reframing of how humans value nature. It is a response to resourcism-the belief held by many people in modern industrial societies that the world gains value only as nature is transformed into goods and services to meet human demands (Grumbine 1992). The biodiversity crisis, so far, has spawned what some would characterize as a scientific ecosystem management based on "value-free" experimentation, control by professional experts, and centralized decisionmaking. To many, however, the promise of the biodiversity crisis is this: adjusting management to stave off mass extinctions and habitat destruction will not only help to reduce our negative impact on the biosphere but will also give us the opportunity to reinterpret our place on the planet as one species among many. Protecting ecological integrity becomes the ultimate test of whether people will learn to fit in with nature. Thus, ecosystem management gains importance far beyond finding new ways to manage parks and forests.

Many of the authors cited in Table 1 recognize this reframing process although few present their views in detail. Kessler et al. (1992), for example, support a stewardship approach though they recognize that "(ecosystems&as living systems have ***importance beyond their traditional commodity and amenity uses***" (authors' emphasis). Keiter and Boyce (1991) observe that the "transition to ecosystem management manifests a willingness to accept nature largely on its own ***terms*** and to control incompatible human uses." Goldstein (1992) suggests that "using ecology to redefine land management implies an ethical reorientation-the ecosystem is valued as an object of respect and admiration." Noss and Cooperrider (1994) go farther: "Biodiversity conservation ultimately requires a rejection of humanism or anthropocentrism .. It requires a biocentric embrace of all life."

Biocentric or ecocentric values (Devall & Sessions 1985; Fox 1990) fit neatly with the management goal of protecting ecological integrity. But, because of dominant values that still support resourcism, a host of practical issues remain. When, for example, will it become politically acceptable to incorporate nonhuman beings into ecological decision making? Do managers have a role to play here?

Encouraging Cooperation

Why are current management relationships competitive instead of cooperative? Most authors writing about eco-

system management agree that competition rules the relationships between all four major groups of actors scientists. managers, policymakers, and citizens. There are numerous studies of how power flows in resource management (see for example Wildavsky 1979; Clark & McCool 1985; Gruber 1987; Grumbine 1991). All of these portray competition as growing out of some mix of divergent legal mandates, agency history, organizational structure, and conflicting professional and personal norms.

Grappling with these questions is vital to the present success of ecosystem management but cooperation is not likely to flourish until a fifth group of actors is recognized-nonhuman beings. The task in transforming cooperation lies not in choosing Park Service professional norms over those of the Forest Service or replacing rigid bureaucracies with consensus-based committees. For the long run, specific methods must evolve that extend cooperation interspecifically based on mutual interests. The goal of protecting ecological integrity is symbolic of such representation-owls and gentians have evolutionary needs as do humans. Yet how interspecific cooperation will develop is difficult to foresee. Christopher Stone (1993) has recently offered a guardianship model where humans would legally represent nonhumans in courts and policy arenas.

Evaluating Success

If, as in adaptive management, ecosystem management is an ongoing experiment, how do we judge when ecological integrity. has been protected? Over the short term, success means making significant, measurable progress toward maintair ing viable populations, representing ecosystem types, etc. But, over a century or more, how do we recognize success?

Nature's bottom line is adaptability-the record of cultures that destroyed their resource base is straightforward (Diamond 1992). The degree to which human economies adjust to nature's economy is certainly part of any standard of achievement for ecosystem management. But many green economy, stewardship, and "sustainability" models suffer from concentrating on efficient management instead of sufficient management. Sufficiency asks of managers the question "How much is enough?" For ecosystem management this means comprehending the balance between core reserves, buffers, and the matrix of lands used more intensively by humans. Noss (1992) has suggested that maintaining 50% of a given region in cores/buffers is a reasonable estimate as to what it may take to conserve biodiversity. He also states that the needs of nonhumans must take precedence over the needs of people. Addressing these provocative observations is critical in the short run, too.

But for the long term, Noss does not go far enough. Just as he advocates for wild nature, hc implicitly discounts human beings and by doing so keeps erect a strict boundary between people and nature. Yet the success of ecosystem management is tangled up with the degree to which this fence must bc reduced or discarded. if maintenance of the boundary is the root problem that has created the biodiversity crisis in the first place. The implication here is that successful ecosystem management, over time, must nurture both the wildlands at the core of the reserve system and the wildness within human beings (Snyder 1990; Grumbine in press a).

Conclusion

History tells us that change does not always come easily, peacefully, or in a planned manner. Implementing the short-term scientific aspects of ecosystem management is daunting enough. For the moment, however, ecosystem management provides our best opportunity to describe, understand, and fit in with nature. We know that the risk of extinction increases under certain conditions, that wildfires cannot long be suppressed without significant successional consequences, that political power must somehow become less centralized, that whales and spiders must also be allowed to vote. We are also coming to realize that resourcism has for so long prevented us from putting our ecological knowledge to work that we are facing the limits of life on Earth for many species. Where once we thought endangered species were the problem, we now face the loss of entire ecosystems (Noss et al. in press).

Ecological integrity will be difficult to protect but the work has already begun. In Florida, on the largest forested Department of Defense military reservation in the U.S., the Air Force and The Nature Conservancy are implementing a management plan to protect biodiversity at all scales (USDOD Air Force 1993; Hardesty in press). In the Netherlands, a country identified by many with large-scale human transformation of nature, a "master plan for nature" is being implemented that eventually will return 14.8 million ha (600,000 acres) of farmland to forest, wetlands, and lakes (Simons 1993).

Ecosystem management, at root, is an invitation, a call to restorative action that promises a healthy future for the entire biotic enterprise. The choice is ours-a world where the gap between people and nature grows to an incomprehensible chasm, or a world of damaged but recoverable ecological integrity where the operative word is hope.

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